1.4 FlowProbe™ Chemical Analyzer

Technology Need

Conventional methods for characterizing hazardous waste sites include field sampling and transportation to laboratories off-site for analysis. This type of analysis is inherently expensive and prone to errors due to the many steps involved. The high costs of laboratory analysis is often viewed as the limiting factor for site characterization. Furthermore, slow laboratory turn-around time can result in operational delays and over treatment of sites. The validity of laboratory results is often questioned due to the loss of volatile constituents during sampling and transportation. It is viewed by some environmental personnel working in the field that at least 70% of samples that are sent to off-site laboratories are useless due to these compromises. Therefore, a need exists for quick, easy, and inexpensive methods for conducting field analysis at hazardous waste sites.

Technology Description

The FlowProbe™ Chemical Analyzer is a small, portable, chemical analyzer that measures chemicals in both liquid and gaseous states. This technology can be used wherever reagent-based chemistry exists that provides analyte concentration information detectable by optical absorption spectroscopy. The FlowProbe™ Chemical Analyzer was designed to be an in situ generic platform for performing wet chemistry-based analyses in field survey, process control, and monitoring applications. It has been packaged both as a bench-top instrument and a down-hole unit. Both configurations can perform up to 500 analyses before the reagent must be replenished. Initially there were two classes of compounds that the FlowProbe™ Chemical Analyzer was targeting: metals and chlorinated organic compounds. All chemistries and sensor materials are compatible with the measurement of analytes in aqueous matrices.

Benefits

The result of this project will be a commercially available FlowProbe™ Chemical Analyzer instrument that will be used to detect a wide variety of chemical species. Though sophisticated algorithms will be used to extract useful information from the reagent chemistry that is occurring, the complexity of the system will be masked. This will allow minimal required training of a field operator. The instruments have been taken to the field and fit into a standard-sized suitcase. The probe tip is constructed out of 316 stainless steel, allowing a variety of field uses.

Applications for this instrument include:

- Rapid site surveys—since the instrument will provide in situ analysis, the field operator can make accurate decisions on where to survey next (this information aids in mapping plume dynamics that can be used to determine feasible and requisite remediation technology).
- Stand alone, long-term, and continuous monitoring/characterization of environmental remediation and restoration sites-an operator can place the instrument in the ground and return weeks or months later to review the results instead of having to return to the site each time a data reading is required.
- In situ monitoring field applications—the ability to monitor samples in the liquid phase, downhole, provides a more representative measurement of analyte concentration (when samples are sent off site for analysis, volatilization of analytes is a concern).

Collaboration/Technology Transfer

Technology transfer to commercial analytical instrument manufacturers is an integral part of this project. Regular contact with personnel associated with the Center for Process Analytical Chemistry (CPAC) at the University of Washington is instrumental in allowing transfer opportunities to occur. The project is a 50/50 collaboration with CPAC at the University of Washington. The wet chemistry and casting and testing of membrane assemblies is addressed by the CPAC scientists. Engineering of a fieldable instrument is addressed by SNL. The project consists of three phases: the initial phase includes obtaining performance requirements from the various CPAC sponsor chemical companies (i.e., users) and working with the CPAC instrument companies (i.e., suppliers) early in the development of the instrument. The second phase is to demonstrate the instrument in the field at DOE and commercial sites. The final project phase is, in collaboration with an instrument manufacturing partner, to make a pre-commercial prototype. LifeSciences of St. Petersburg, FL, signed a commercialization agreement on February 12, 1996. A first generation prototype based on the SNL design is being brought to market in late summer 1996. Letters of interest from other CPAC companies, including in-kind support commitments that range from $200K (Dow USA) to $50K (Perkin-Elmer Corporation) have been received. Other companies expressing interest and in-kind support commitments include: Amoco, Calgon, Chevron, Sippican, Goodyear, Hewlett-Packard, Proctor & Gamble; Shell, and ZymoGenetics.

Accomplishments

Since the project started in November 1993, the following has been accomplished:

- Industry has been solicited for input on instrument usage and design requirements.

Responses were obtained from 25 different potential commercial users and instrument manufacturers. Based on the industry identified requirements, we partitioned the functions of the instrument into seven subsystems: six hardware-related and one chemistry-related.

- SNL led a conceptual design review in which representatives from CPAC sponsor companies and personnel from Los Alamos National Laboratory (LANL) and SNL worked together to define the operational needs for the FlowProbe™ system model. Subsequent to this meeting and after design of a prototype, SNL organized a prototype design review with CPAC industry sponsor representatives and scientists from LANL and SNL to review the technical status of the project.
- SNL designed and built test pieces of subsystem assemblies as individual units.
- Multiple probe heads were assembled for testing the subsystems as complete units.
- Various polymer membranes were cast and examined using the probe heads for chemical compatibility and analyte partitioning into the reaction cell.
- Four different field tests were performed:
- W.R. Grace, monitoring water in a pilot plant for boiler water. Established 250 ppb detection limit with 80% precision.
- Dow Corning, monitoring Cu in silane processing stream. Ran on-line one week unattended with a 250 ppb detection limit.
- Martin Marietta Specialty Components Division, monitoring of chlorinated organics was attempted at a remediation site. Due to external forces, the instrument did not go on line.
- Dow Chemical, tested bench top in lab. Standard addition of analytes in water was successful, but had matrix problem of actual process line chemicals. Test was inconclusive.
- Probe assemblies were delivered to Boeing and LANL for testing and evaluation.
- Down-hole, or submarine unit, has been built and lab tested.

- Active in commercialization activities with LifeSciences, St. Petersburg, FL.

TTP Information

FlowProbe™ Chemical Analyzer technology development activities are funded under the following technical task plan (TTP):

TTP No. AL24C222 "FlowProbe™ Chemical Analyzer"

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Bibliography of Key Publications

None available at this time.